

# HIGH TEMPERATURE SCR SYSTEMS ON FRAME SIZE COMBUSTION TURBINES

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## Summary

It has been shown over the last few years that high NOx reductions with acceptable ammonia slip can be achieved with SCR systems on aero-derivative combustion turbines in open cycle. NOx levels below 2.5 ppmvd (15% O<sub>2</sub>) with ammonia slip well below 10 ppmvd have been achieved on aero-derivative combustion turbines providing up to 46 MW of power.

SCR systems on boilers and in Heat Recovery Steam Generators (HRSG) typically use 3% vanadium pentoxide as the active material in the catalyst. The operating temperatures for these types of SCR reactors are in the 550°F to 750°F range. Combustion turbines in open cycle run at significantly higher temperatures. The aero-derivative turbines have exhaust temperatures ranging from 750°F to over 1000°F. Frame size combustion turbines run as hot as 1200°F. Hamon Research-Cottrell has experience in reducing NOx as much as 90% on high temperature frame size combustion turbines in open cycle. Items to be considered are the type of catalyst, the pressure drop across the system, and the amount of parasitic loads for the exhaust cooling fans. Issues such as the effect on catalyst life expectancy in case of cooling system malfunction and the flexibility in catalyst suppliers are very important.

This paper provides details on ammonia behavior at elevated temperatures, evaluation of different types of catalysts at different operating temperatures and operation with distillate fuels as back up. A basic economic model, including the life cycle evaluation of the different options available is presented. It is possible for most frame size combustion turbines to cool the exhaust down to around 850°F and use a vanadium pentoxide based catalyst (< 3% V<sub>2</sub>O<sub>5</sub>). This solution provides the lowest cost catalyst and the highest flexibility in catalyst choices. Parasitic loads may become excessive, however, and the catalyst will be damaged irreversibly in case of an exhaust cooling system malfunction. Alternatives are the use of zeolite catalysts and titanium dioxide with tungsten based catalysts. The number of catalyst suppliers for these solutions is limited, however. Our investigations have identified a number of quality suppliers of titanium dioxide and zeolite catalysts. These catalysts are effective in the 850°F to 1050°F and it is possible to achieve 80% to 90% NOx reduction using SCR technology on frame size combustion turbines in open cycle. As a result, parasitic loads for exhaust cooling are reduced and damage to the catalyst, which may be caused by unwanted temperature excursions, is less than with the vanadium-based catalysts.

When ammonia is injected in the turbine exhaust at elevated temperatures ammonia degradation takes place. Consequently, cooling of the exhaust gasses needs to be modeled to assure proper temperature and flow uniformity. Catalyst efficiency varies with temperature, and so does catalyst degradation. Hamon Research-Cottrell has its own flow-modeling laboratory where physical and CFD models are developed and analyzed. High exhaust gas turbulence and extreme temperature ramping in the exhaust of frame-size combustion turbines represent additional challenges to the design engineers. Practical field experience to validate and correct the assumptions and the findings from the flow models is extremely valuable.

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**References:** Materials and information used from CERAM-Frauenthal, Haldor Topsøe, Hitachi-Zosen, Engelhard, ICAC White Papers, DOE publications.